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AN OPTICAL FIBER ILLUMINATING DEVICE

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AN OPTICAL FIBER ILLUMINATING DEVICE

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[There are no amendments to this patent.]

Specification

1. Title of the invention

An optical fiber illuminating device

2. Claims of the invention

1. An optical fiber illuminating device wherein flaws that reach the core of the optical fiber are formed on the surface of the cladding layer of an optical fiber both ends of which are connected to light sources, and photoelectric power is radiated radially from the optical fiber by light leaking from the light from the above-mentioned flaws; the density of the flaws is non-uniform in the extension direction of the optical fiber.

2. The optical fiber illuminating device specified in claim 1 above wherein the flaws are formed along the optical fiber at a density

$$n = \frac{1}{Ce^{-\gamma}} \quad \text{from } \gamma=0 \text{ to } \gamma=1/2,$$

and at a density of

$$n = \frac{1}{Ce^{-1(1-\gamma)}} \quad \text{from } \gamma=1/2 \text{ to } \gamma=1$$

where the density of the flaws is defined as n, the position on the optical fiber in the direction of extension is γ, the length of the optical fiber to be illuminated is 1, and C is a constant.

3. Detailed explanation of the invention

The present invention pertains to an improved optical fiber illuminating device.

In the past, the above-mentioned type of device has had the structure shown in Fig. 1 or Fig. 2. Fig. 1 shows the case of a single core, wherein (1) is the light source, (2) is the optical fiber, one end of which is connected to the above-mentioned light source, and light from light source (1) from a lens or parabolic reflecting mirror (not shown in the fig.), is applied to one end (A) in such a manner that diffusion of the light does not occur. (3) is the light exiting from the other end (B) of the optical fiber.

Fig. 2 shows the case of a multicore fiber optic, and many of the single core fibers shown in Fig. 1 are bound to form an optical fiber with multiple cores (2).

Light source (1) is installed in alignment with the multicore optical fiber, and photoelectric power is applied to the optical fiber through a lens, etc. as in the case of Fig. 1. (3) is the applied light exiting from each end of the multiple optical fibers. Light can be efficiently applied at end (B) of the optical fiber in a conventional optical fiber illuminating device with the above-mentioned structure, but the illumination is a point of light at end B; thus, the field of illumination is narrow.

[p. 2]

As a means to eliminate the above-mentioned disadvantage, a method wherein linear light is applied in the direction of extension of the optical fiber by leaking light from areas other than the end of optical fiber is being studied.

The method is explained below.

In Fig. 3, (1) is the light source and two light sources are installed in order to connect with both ends. (2) is optical fiber, and has a structure consisting of the core (not shown in the fig.) that forms the central part and cladding (not shown in the fig.) that covers the surface of the core. (4) are flaws formed in the cladding layer of the optical fiber, and each flaw reaches the core of the central optical fiber. (5) is light radiated outward at the above-mentioned flaws.

Also, many the above-mentioned flaws (4) are formed on the surface of the optical fiber, and the density of the flaws is adjusted so that the light intensity remains constant.

In this case, the photoelectric power injected from both ends of the optical fiber is reduced at a rate of

$$X = Ce^{-\gamma}$$

where x .... photoelectric power   C .... constant

γ ....distance from the end (photoelectric power injection end) of optical fiber in the direction of extension toward the midpoint of the optical fiber. The photoelectric power that passes through the optical fiber is leaked outward at a constant rate via photoelectric power at the surface of the optical fiber.

Therefore, a linear illumination can be emitted from the entire optical fiber, but the brightness is gradually attenuated toward the midpoint.

The present invention is to eliminate the above-mentioned existing problem, and in the present invention, many flaws that reach the optical fiber core are formed on the surface of the cladding layer as in the case of the optical fiber shown in Fig. 3, but in this case, the density of flaws is made non-uniform in the direction of extension of the optical fiber.

In other words, the photoelectric power injected from both ends of the optical fiber undergoes attenuation toward the midpoint of the optical fiber, thus, the density of flaws formed on the surface of the optical fiber is increased toward the midpoint of the optical fiber.

When the position to the right from the left end of the fiber in Fig. 3 is defined as γ, and the length of the optical fiber to be lighted is defined as l, flaws are formed at each point along the optical fiber at a density

$$n = \frac{1}{Ce^{-\gamma}} \quad \text{from } \gamma=0 \text{ to } \gamma=1/2,$$

and at a density of

$$n = \frac{1}{Ce^{-1(1-\gamma)}} \quad \text{from } \gamma=1/2 \text{ to } \gamma=1$$

The density distribution of the above-mentioned flaws is shown in Fig. 4. When the above-mentioned structure is used, attenuation of the photoelectric power can be compensated by the increased density of the flaws; thus, the leakage photoelectric power radiated through the flaws becomes constant over nearly the entire length of the optical fiber, and the same level of brightness can be achieved over the entire length.

However, it is necessary that the value of constant C be such that the photoelectric power injected from both ends is completely leaked from the system at the midpoint of the optical fiber of Fig. 3.

Also, in the above-mentioned explanation, the type of optical fiber used, material used for the optical fiber, and the structure of the optical fiber are not especially mentioned, and for the light source, sunlight, a laser beam, semiconductor light source, light bulb based on a filament system, etc. can be used, and for the material used for the optical fiber, either a glass fiber or a resin fiber can be used, and either the step index type or graded index type can be used.

Furthermore, in this case, the shape of the flaws is not especially limited, and, for example, ring-shaped flaws, spiral-form flaws, pinholes, etc. can be used.

The present invention has the structure described above, and flaws that reach the optical fiber core are formed on the surface of the cladding layer of the optical fiber with both ends connected to the light source, and photoelectric power is applied radially from the optical fiber by leakage of the light from the above-mentioned flaws, the density of the flaws is made non-uniform in the direction of extension of the optical fiber; thus, a constant brightness can be achieved in the direction of extension of the optical fiber.

[p. 3]

4. Brief description of figures

Fig. 1 and Fig. 2 show diagrams of conventional devices, Fig. 3 shows a diagram of the optical fiber with flaws formed on the surface, and Fig. 4 is a graph that shows the relationship between the density and position of the flaws [along the length of the fiber].

In the figures, (1) is the light source, (2) is the optical fiber, (4) are the flaws, and (5) is the radiated light. It should be noted that the same codes are used in different figures to indicated the same item.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 4 legend:

Vertical axis: Density of flaws (n)

Horizontal axis: Position (γ)